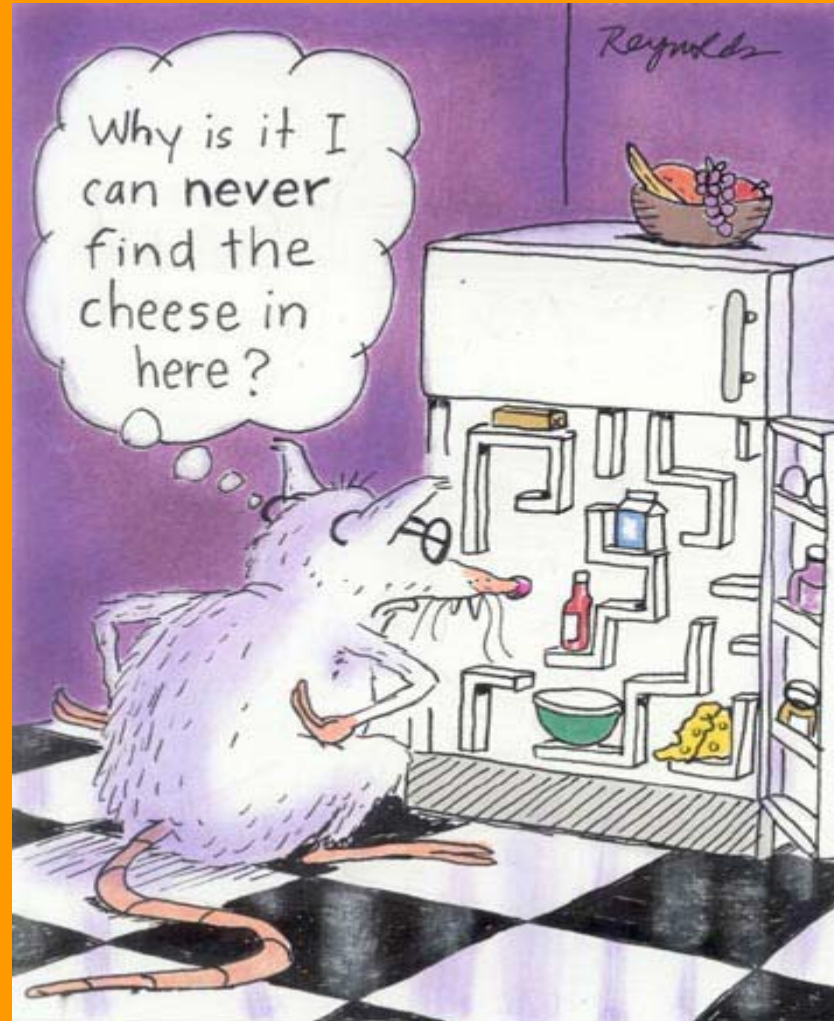


Anatomy and Pathomechanics of the Sacrum and Pelvis



Charles R. Thompson
Head Athletic Trainer
Princeton University



Simplify Everything

- There are actually only three bones:
 - Two innominates, one sacrum.



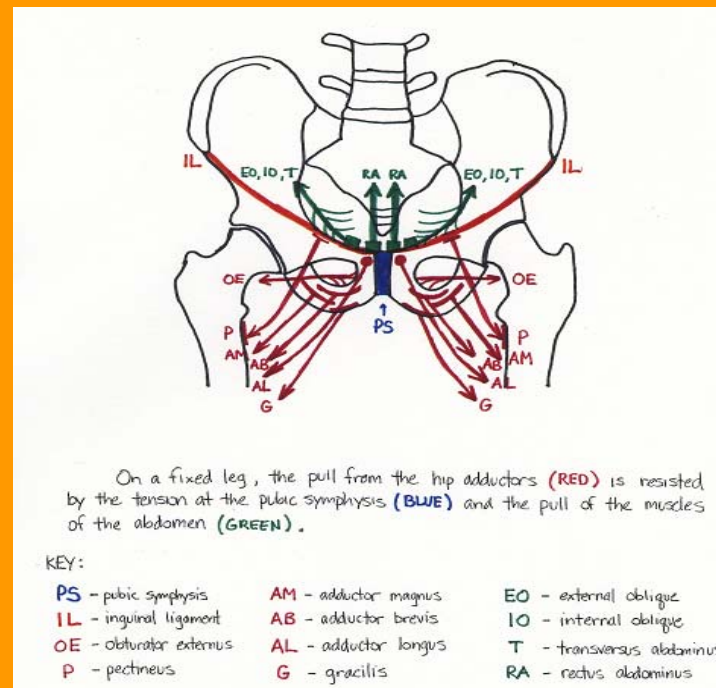
Simplify Everything

- There are only three joints:
 - Right and left sacroiliac joint;
 - Pubic symphysis.



Simplify Everything

- There are 45 muscles that attach on the pelvis, however, we will mostly deal with them in groups.



Os Innominate

- Ilium
- Ischium
- Pubis

Os Innominate

- Ilium
 - Supports the flank.

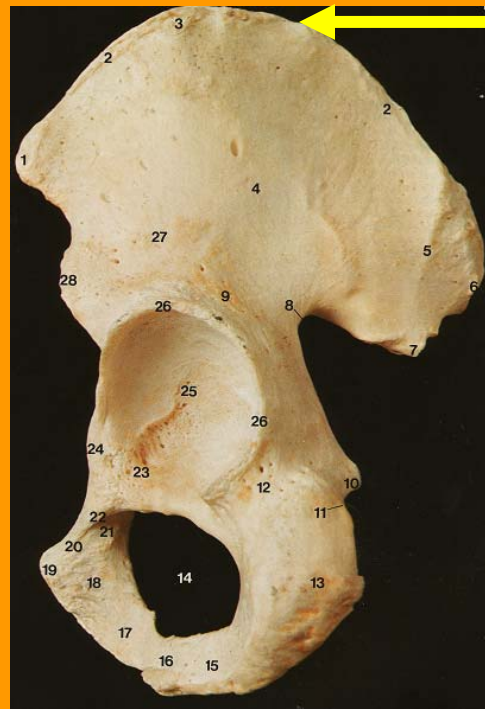


McMinn & Hutchings, Color Atlas Of Human Anatomy, Year Book Med Pub, 1977

Os Innominate

- Ilium

- Runs upward from the acetabulum to form the broad, expanded portion called the iliac crest.



Iliac crest

Os Innominate

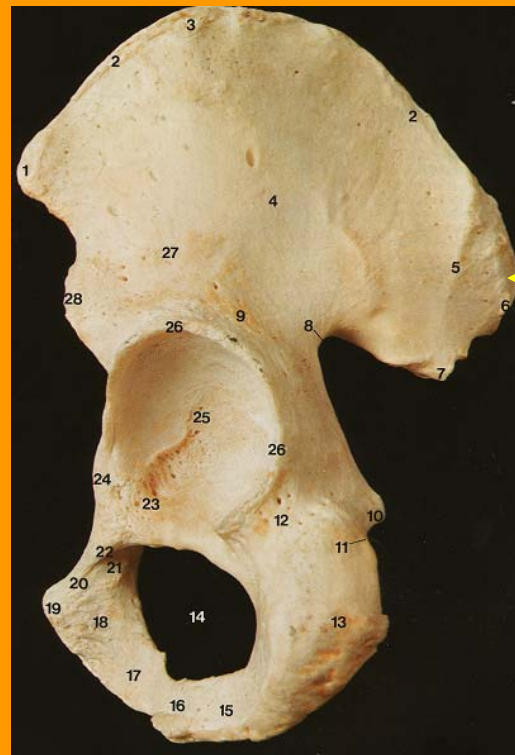
- Ilium

- *ASIS*- from the anterior border; attachment of sartorius.
- *AIIS*- attachment of the rectus femoris and ilio- femoral ligament.



Os Innominate

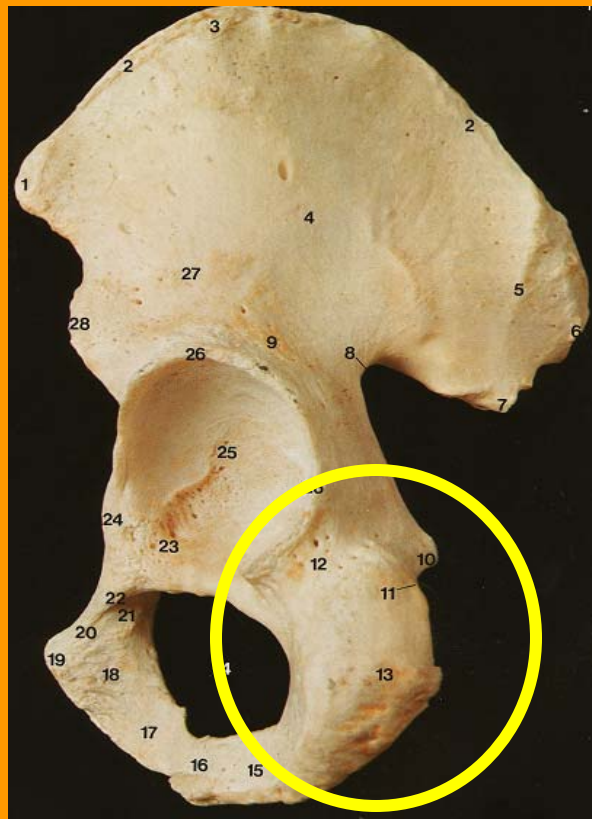
- Ilium
 - *PSIS*- projection off of the shorter posterior border.



McMinn & Hutchings, Color Atlas Of Human Anatomy, Year Book Med Pub, 1977

Os Innominate

- Ischium
 - The most inferior and the strongest portion of the os innominate.



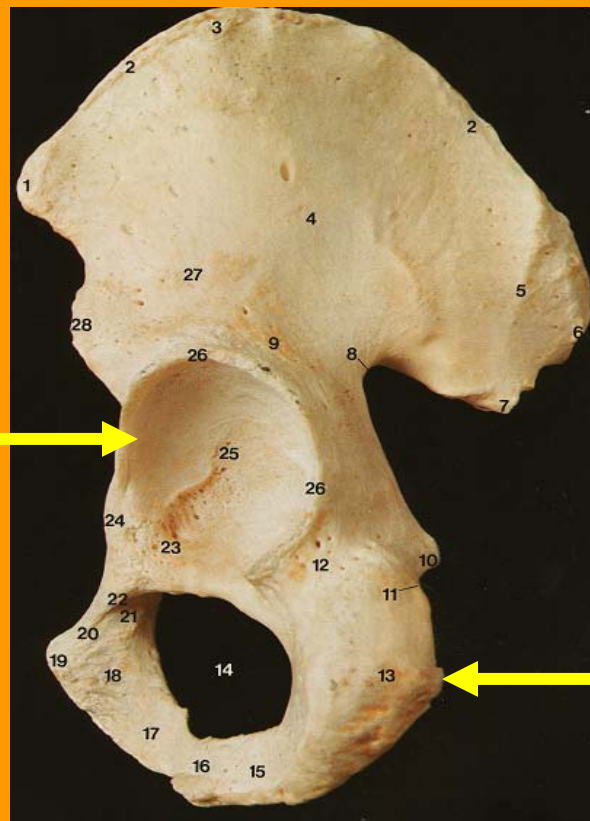
McMinn & Hutchings, Color Atlas Of Human Anatomy, Year Book Med Pub, 1977

Os Innominate

- Ischium

- Proceeds downward from the acetabulum and expands into the *ischial tuberosity*.

Acetabulum



Ischial tuberosity

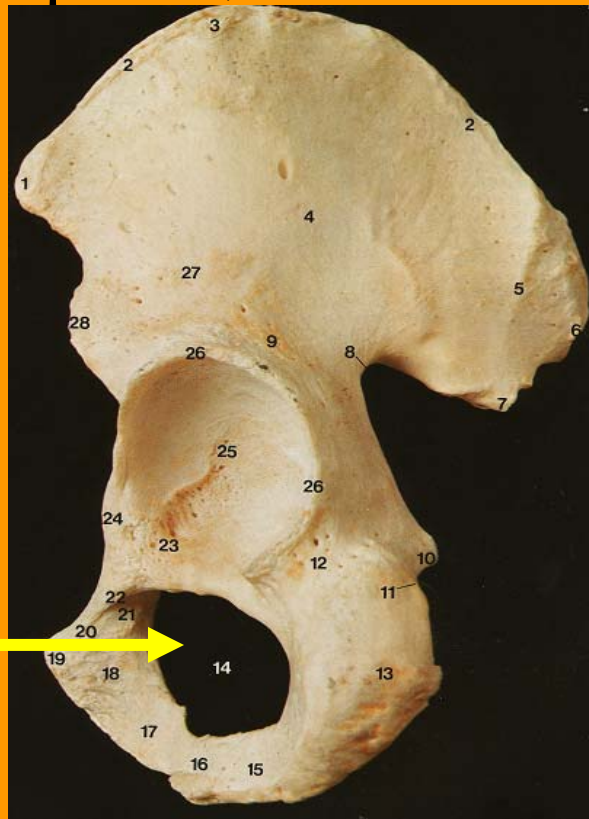
McMinn & Hutchings, Color Atlas Of Human Anatomy, Year Book Med Pub, 1977

Os Innominate

- Ischium

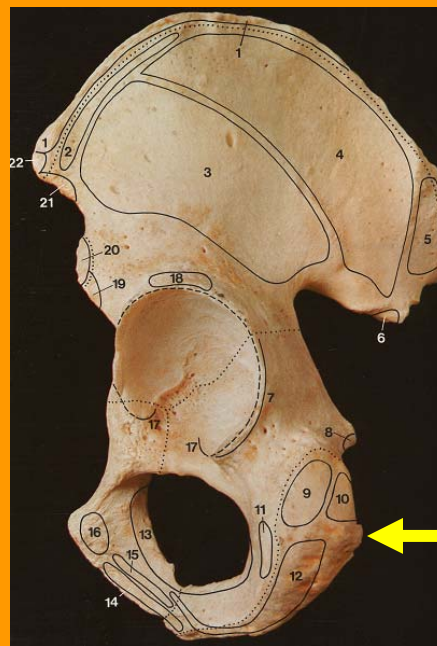
- Curves forward and, with the descending ramus of the pubis, forms the *obturator foramen*.

Obturator foramen



Os Innominate

- Ischium
 - *Ischial tuberosity* is the site of attachment for the sacral- sciatic ligament and the three muscles of the hamstring group.



Ischial tuberosity

Os Innominate

- Pubis
 - Extends inward and downward from the acetabulum to articulate at the midline with the opposite side.

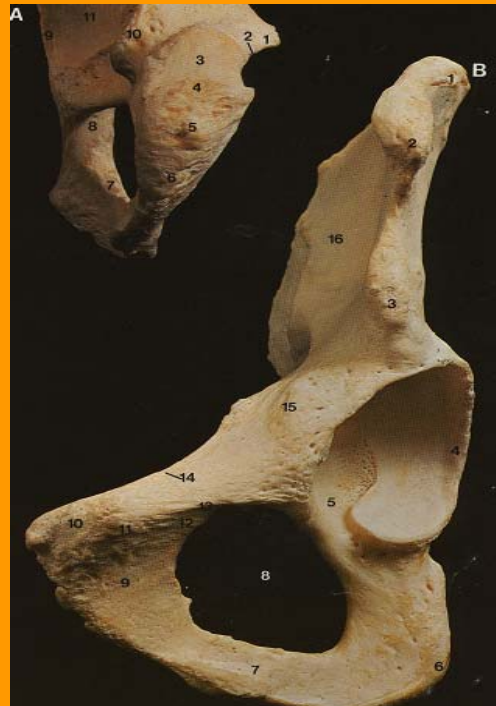


McMinn & Hutchings, Color Atlas Of Human Anatomy, Year Book Med Pub, 1977

Os Innominate

- Pubis
 - Forms the front of the pelvis.

Pubic
symphysis

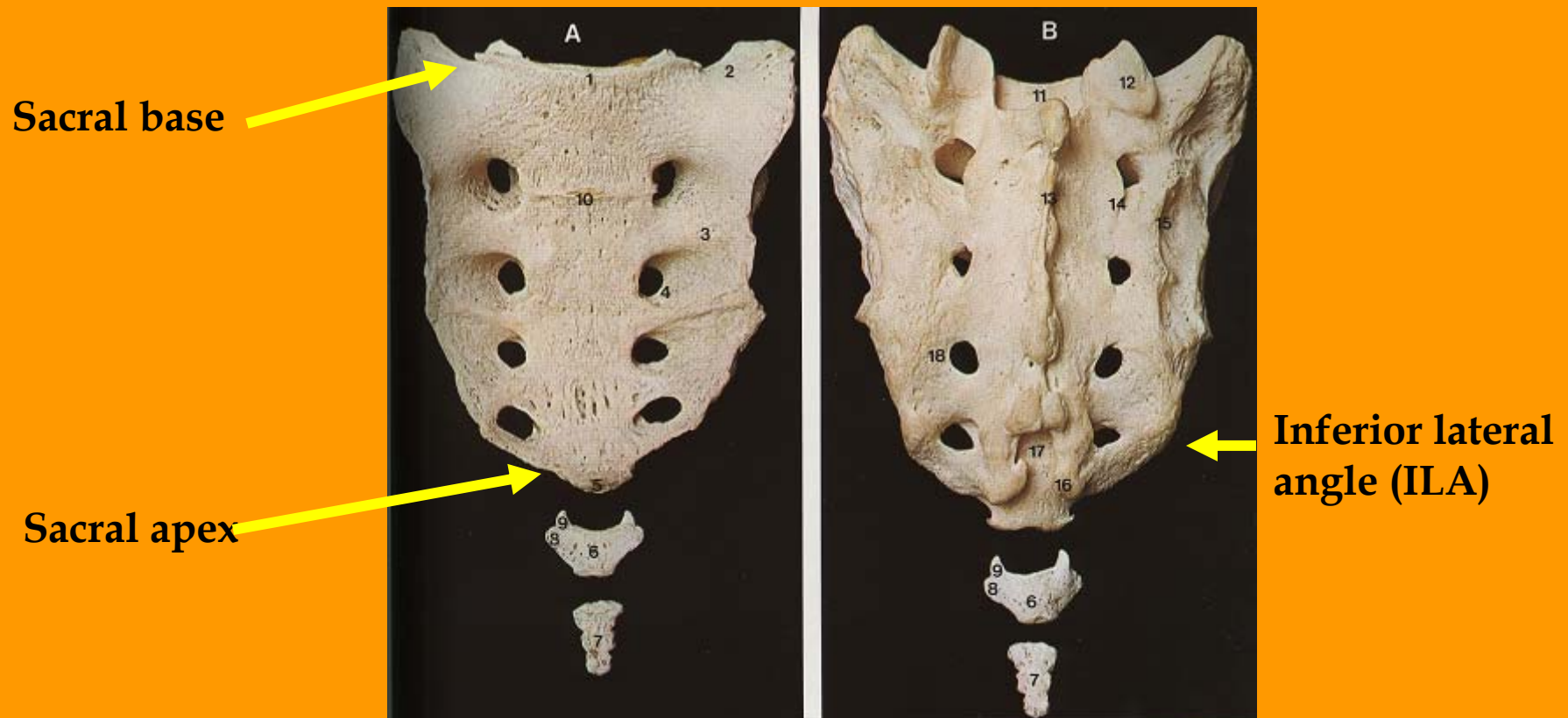


McMinn & Hutchings, Color Atlas Of Human Anatomy, Year Book Med Pub, 1977

Sacrum

- The sacrum is the result of the fusion of 5 vertebral elements.
- It is broad at its base (superior aspect) and narrows to its apex (inferior aspect).
- The inferior lateral angle (ILA) is located at the level of the transverse process of S₅.

Sacrum



McMinn & Hutchings, Color Atlas Of Human Anatomy, Year Book Med Pub, 1977

Sacrum

- Transitional vertebrae (variation) = sacralization of L₅.



Sacralized L₅

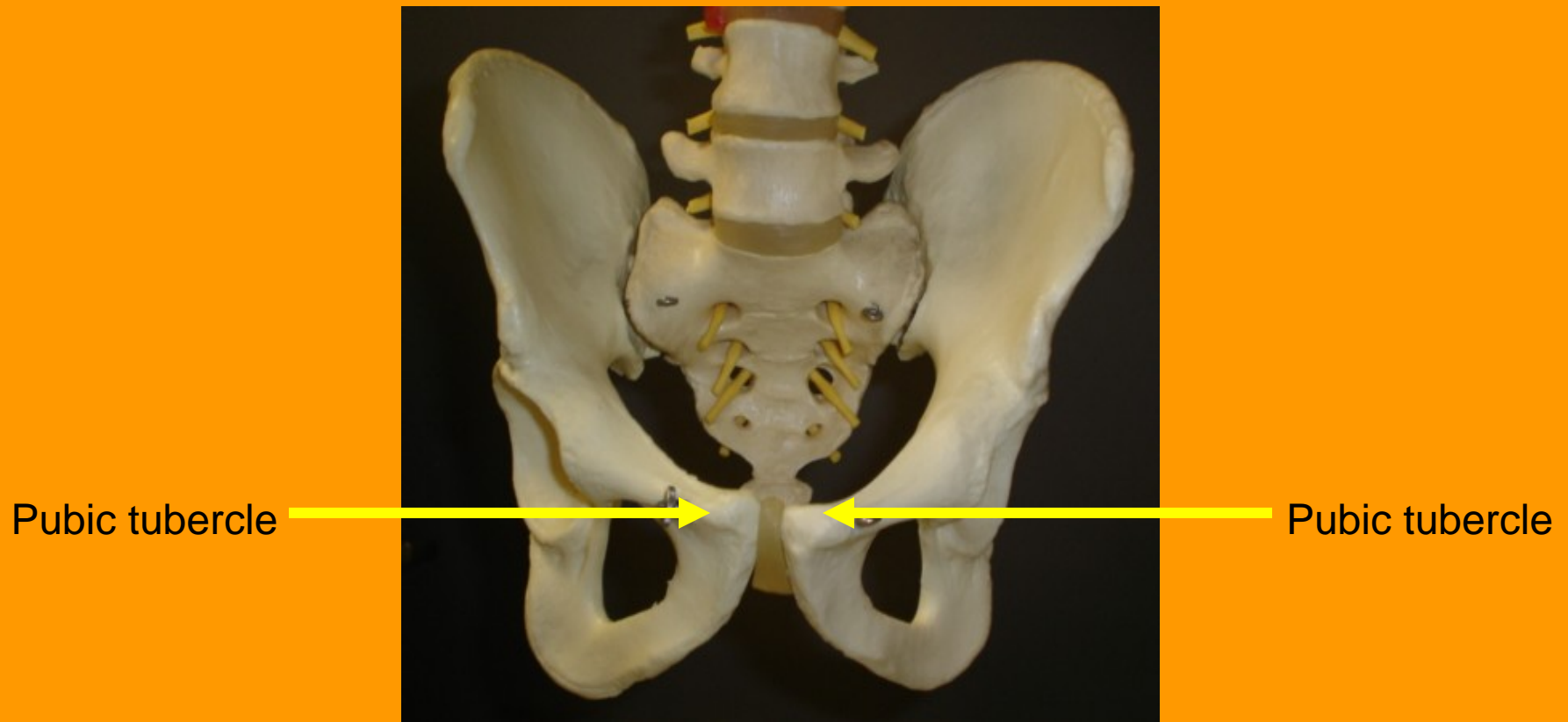
McMinn & Hutchings, Color Atlas Of Human Anatomy, Year Book Med Pub, 1977

Sacrum

- Transitional Vertebrae (variation) = *lumbarization* of S_1 , resulting in a sixth lumbar vertebrae, and only four sacral vertebrae.
- Both variations are significant in that the mechanics of the low back and pelvis are altered.

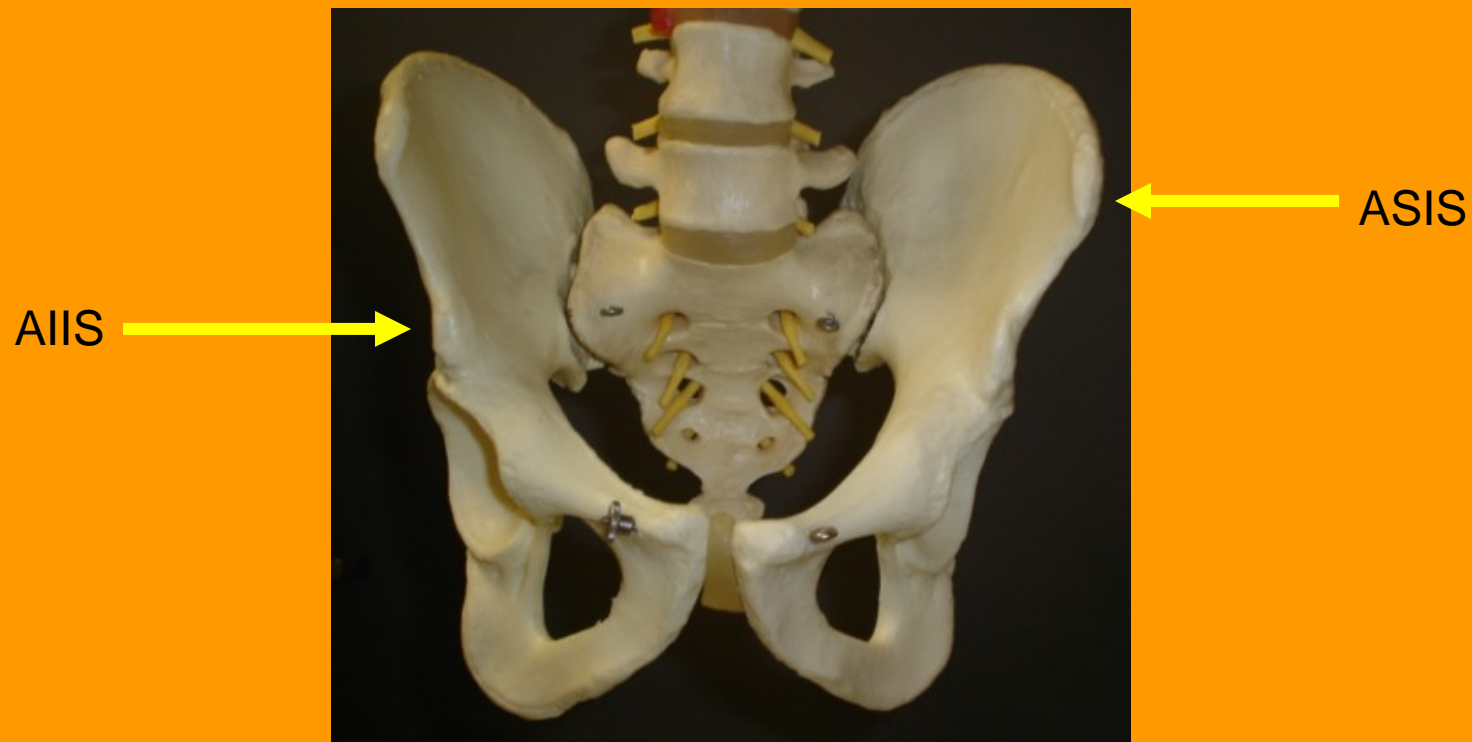
Important Bony Landmarks

- Pubic tubercles



Important Bony Landmarks

- Anterior Superior Iliac Spine
- Anterior Inferior Iliac Spine



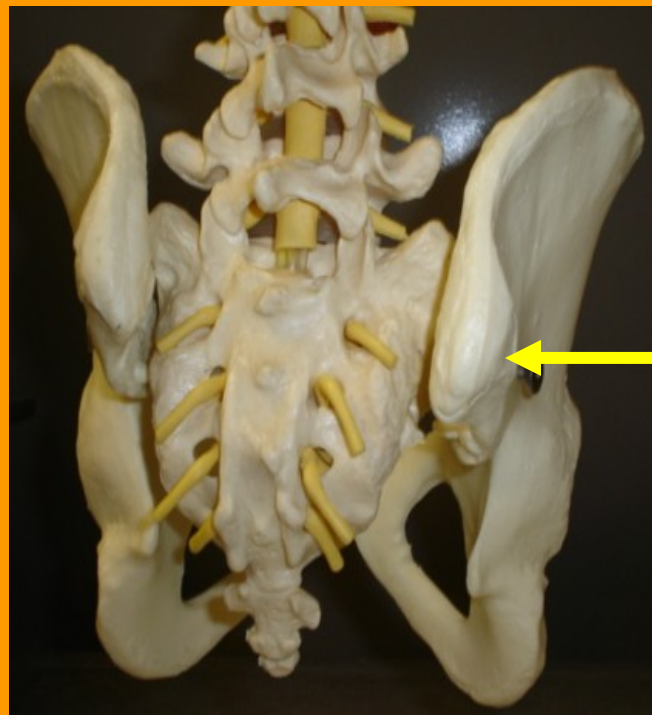
Important Bony Landmarks

- Iliac Crest



Important Bony Landmarks

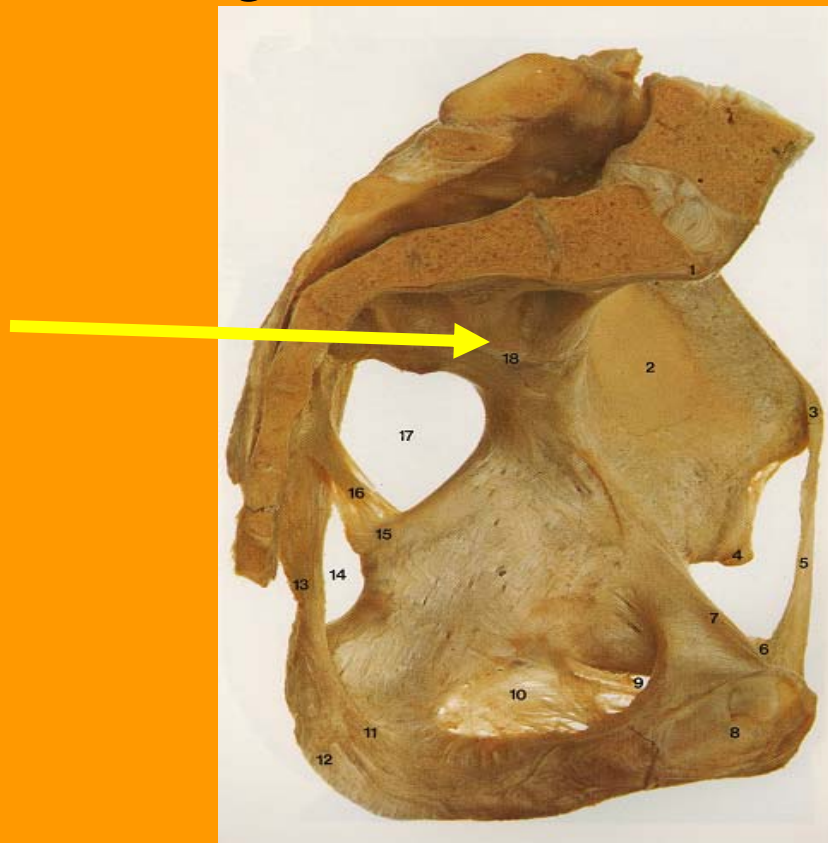
- Posterior Superior Iliac Spine



PSIS

Ligaments of Note

- Anterior Sacro- iliac
 - Connects the anterior surfaces of the sacrum and the ilium.
 - Acts as a “sling” between the two bones.



McMinn & Hutchings, Color Atlas of Human Anatomy, Year Book Med Pub, 1977

Ligaments of Note

- Posterior Sacro- iliac
 - Considered the chief bond between the two bones.
 - Consists of several bands.
 - Travel from the posterior arches of the sacrum to the medial aspect of the ilia.

Ligaments of Note

- Inguinal Ligament
 - Arises from the ASIS and extends caudally to the spine of the os pubis.



Ligaments of Note

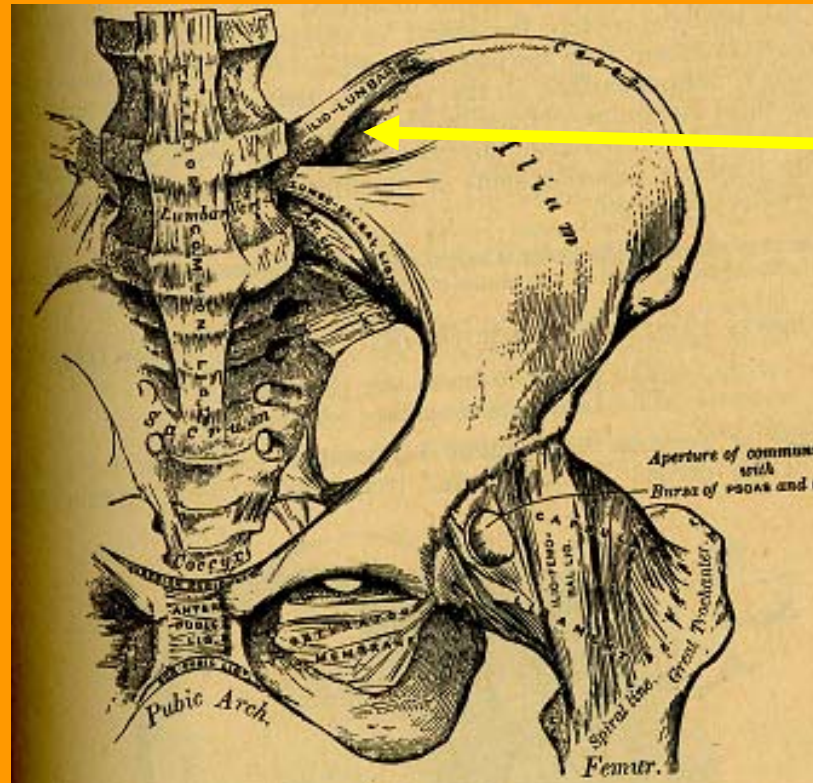
- Lesser or Anterior Sacro- sciatic
 - Attaches the spine of the ischium to the lateral margin of the sacrum.

Ligaments of Note

- Greater or Posterior Sacro- sciatic
 - Attaches the the posterior inferior spine of the ilium to the 4th and 5th transverse tubercles of the sacrum.

Ligaments of Note

- Ilio- lumbar
 - Attaches the transverse processes of L₄ and L₅ to the anterior surface of the iliac crest.



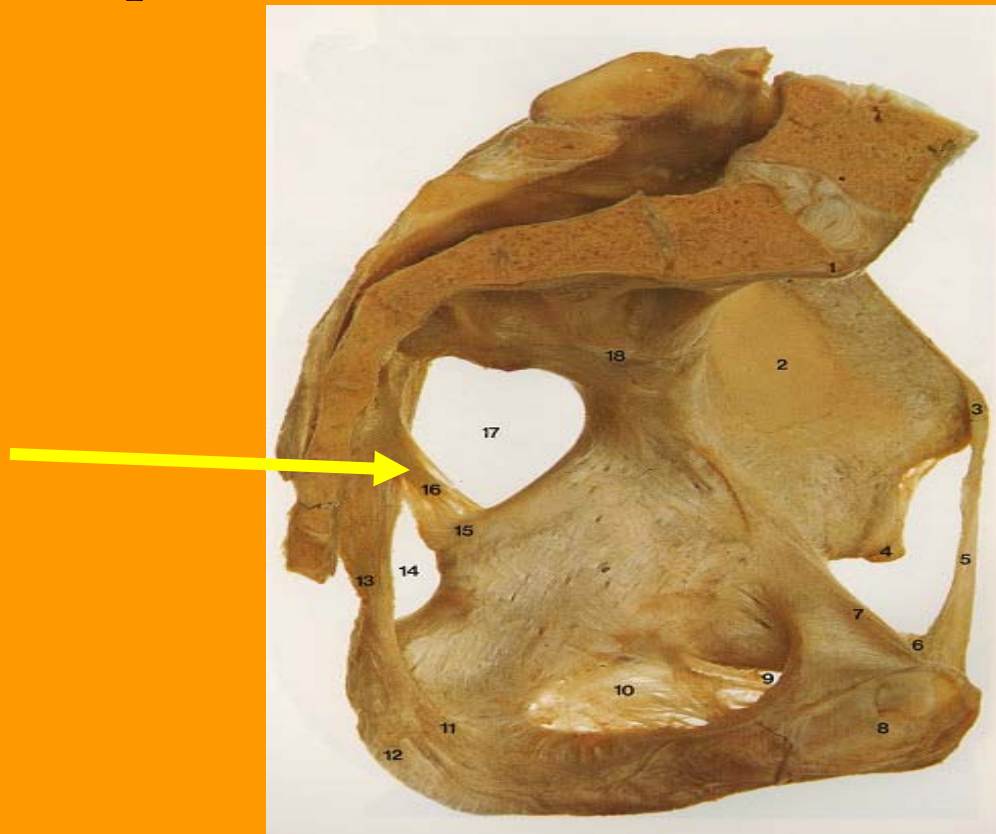
Ligaments of Note

- Sacrotuberous
 - Arises from the inferior lateral angle (ILA) of the sacrum and attaches on the ischial tuberosity.



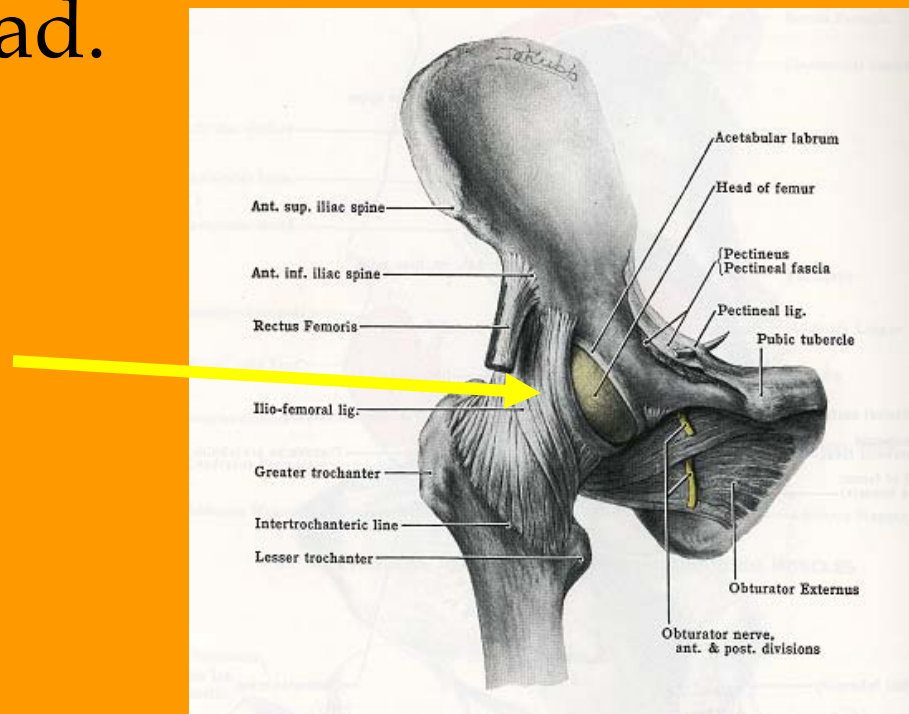
Ligaments of Note

- Sacrospinous
 - Arises from the ischial spine and attaches on the sacrum.
 - Forms part of the obturator foramen.



Ligaments of Note

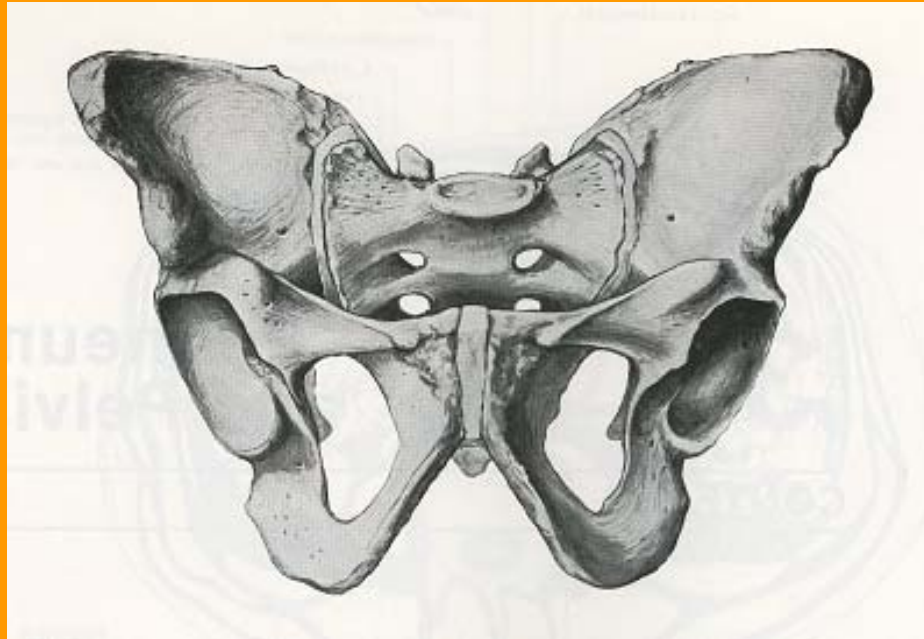
- Ilio- femoral
 - Arises from the AIIS and crosses the front of the joint to attach on the femoral head.



Anderson, Grant's Atlas of Anatomy, Williams & Wilkins, 1983

Ligaments of Note

- Pubic Ligaments
 - Anterior, posterior and superior.
 - Names speak for themselves.



Anderson, Grant's Atlas of Anatomy, Williams & Wilkins, 1983

Ligaments of Note

- Lumbo- sacral
 - Arises from the transverse process of L₅ and attaches on the base of the sacrum.

Musculature of Note

- As mentioned, there are 45 muscles that attach somewhere on the pelvis.
 - 16 attach on the ilium.
 - 13 attach on the ischium.
 - 16 attach on the pubes.

Musculature of Note

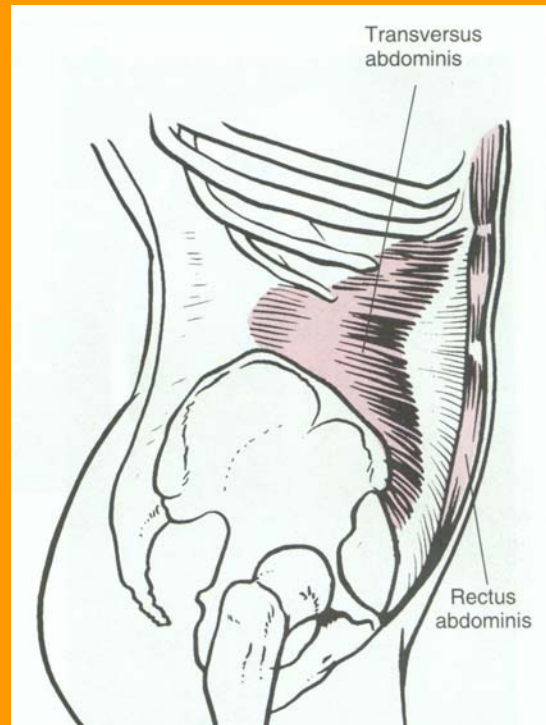
- Do not need to review the origin, insertion, and action of 45 muscles.
- Are soft tissue dysfunctions (tightness, strain, etc.) the cause of or are they an effect of pelvic and sacral dysfunctions?

Musculature of Note

- How do “muscular” issues become resolved without the use of Muscle Energy?
- Which muscle groups are most involved?

Trunk Muscles

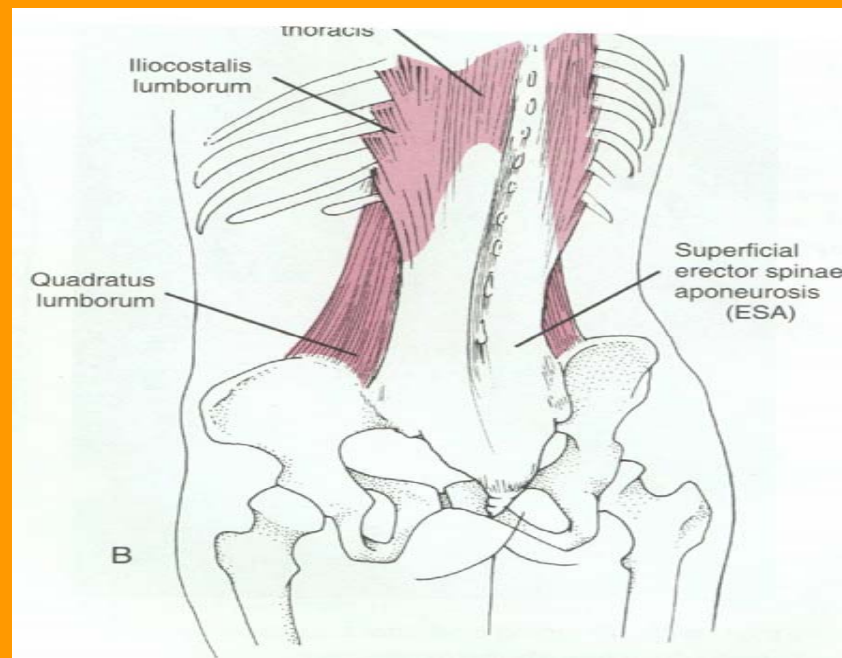
- Transverse Abdominus
 - Originates from the inguinal ligament, the anterior aspect of the iliac crest, and the lower six ribs.
 - Inserts at the linea alba.
 - Trunk stabilization.



Trunk Muscles

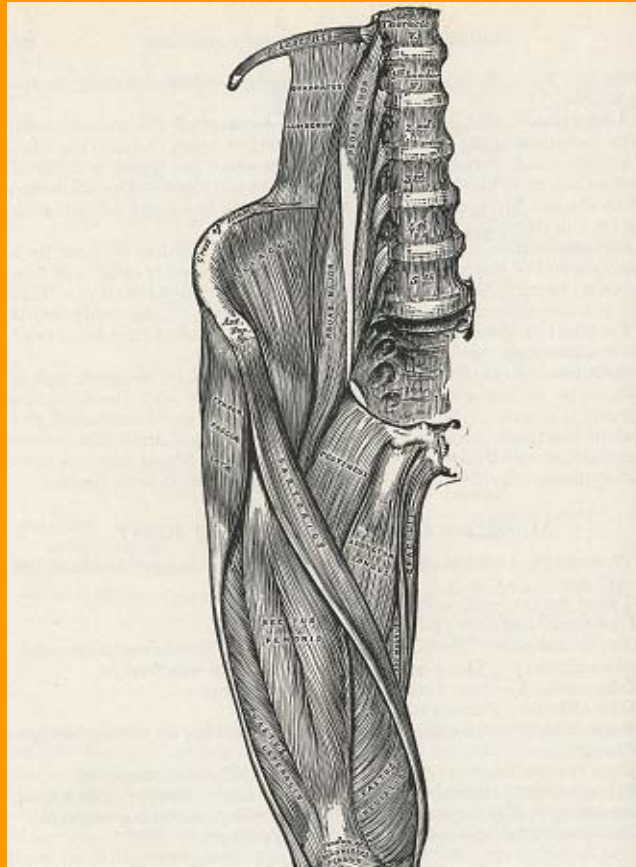
- Quadratus Lumborum

- Originates on the iliac crest and the TP's of the lower four lumbar vertebrae.
- Inserts on the TP's of the upper two lumbar vertebrae and the last rib.
- Prime mover for lateral flexion to the same side and spinal stabilization.



Hip Flexors

- Psoas, Iliacus, Rectus Femoris, Sartorius.



Anderson, Grant's Atlas of Anatomy, Williams & Wilkins, 1983

Hip Flexors

- Psoas
 - Originates on the last thoracic and all of the lumbar vertebrae.
 - Inserts on the lesser trochanter of the femur.
 - Important in initiating the advancement of the thigh during the early swing phase of walking.

Hip Flexors

- Iliacus
 - Originates on the inner surface of the ilium and the inner sacrum near the ilium.
 - Inserts with the psoas at the lesser trochanter of the femur.
 - Strong hip joint flexor and stabilizer of the pelvis.

Hip Flexors

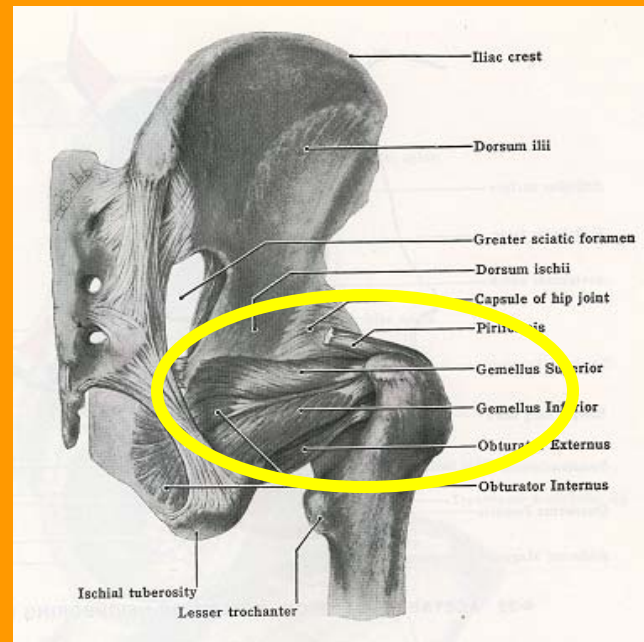
- Rectus Femoris
 - Originates at the anterior inferior spine of the ilium.
 - Inserts in a common tendon at the knee joint.
 - Prime mover for hip flexion.

Hip Flexors

- Sartorius
 - Originates on the anterior superior spine of the ilium.
 - Inserts at the medial proximal tibia.
 - Directly assists hip flexion, hip abduction, and hip external rotation.

Muscles of the Buttocks

- Six Outward Rotators
 - **Piriformis**, obturator internus and externus, quadratus femoris, and the inferior and superior gemelli.
 - All originate from the posterior pelvis and insert on the greater trochanter.
 - All are responsible for external rotation.

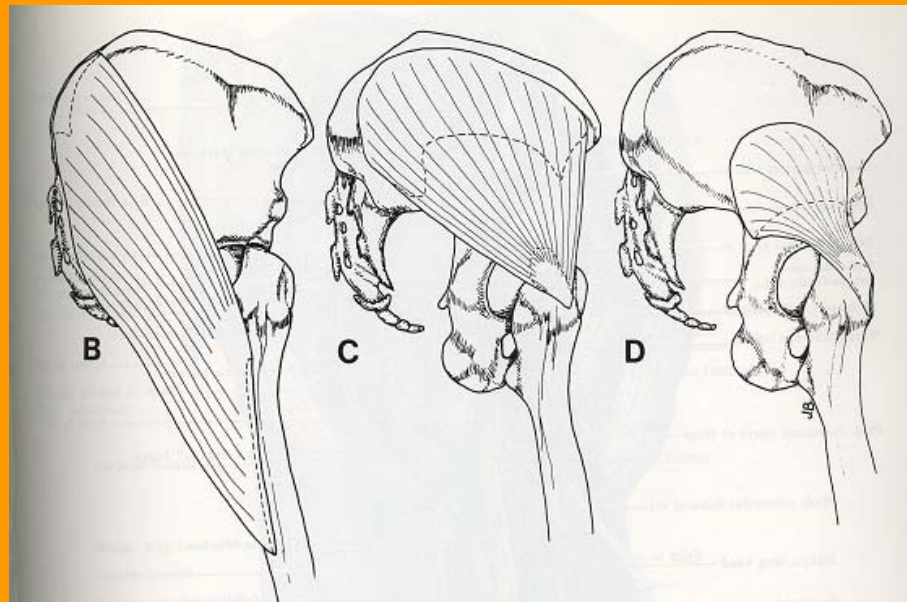


Anderson, Grant's Atlas of Anatomy, Williams & Wilkins, 1983

Muscles of the Buttocks

- Gluteus Maximus

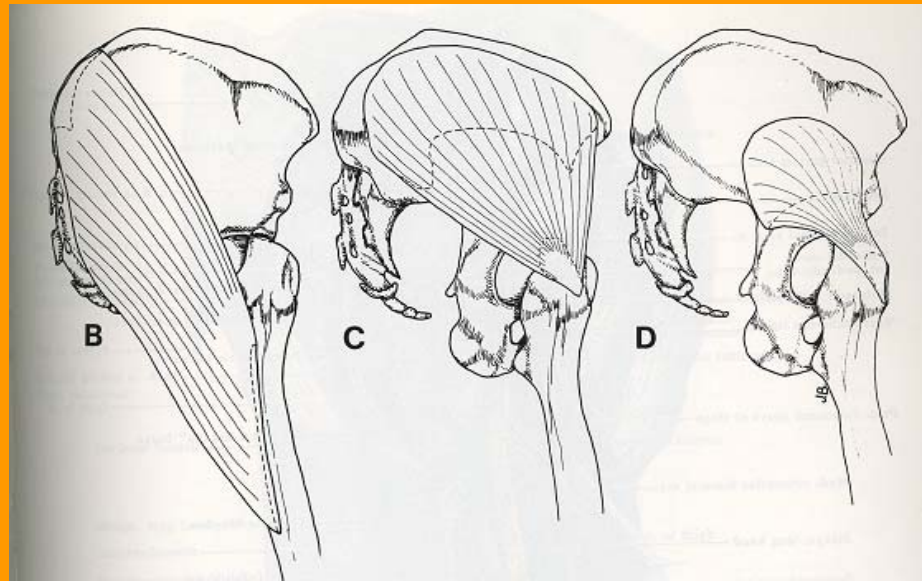
- Originates at the outer surface of the ilium and the posterior sacrum near the ilium.
- Inserts on the posterior aspect of the femur.
- Responsible for hip extension, external rotation, and abduction.



Anderson, Grant's Atlas of Anatomy, Williams & Wilkins, 1983

Muscles of the Buttocks

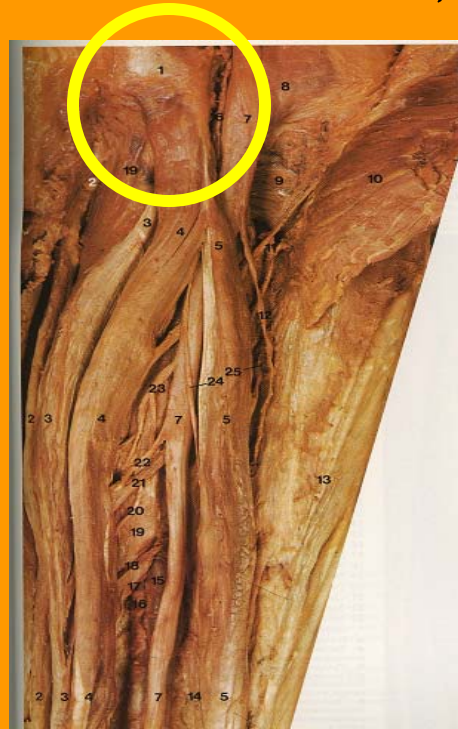
- Gluteus Medius and Minimus
 - The medius originates at the outer ilium near the crest and the minimus originates from the lower, outer ilium.
 - Both insert on the greater trochanter.



Anderson, Grant's Atlas of Anatomy, Williams & Wilkins, 1983

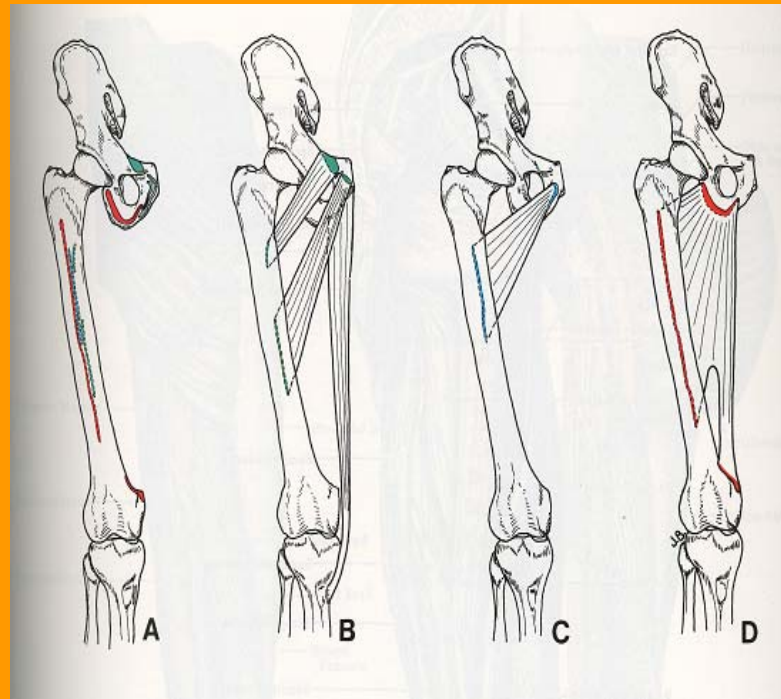
Hamstrings

- Bicep Femoris, Semimembranosus, Semitendinosus
 - All originate at the ischial tuberosity.
 - The BF inserts at the lateral tibia and the fibular head; the ST inserts at the medial tibia; the SM inserts at the medial tibia.



Adductors

- Gracilis, Adductor Longus, Adductor Brevis, Adductor Magnus

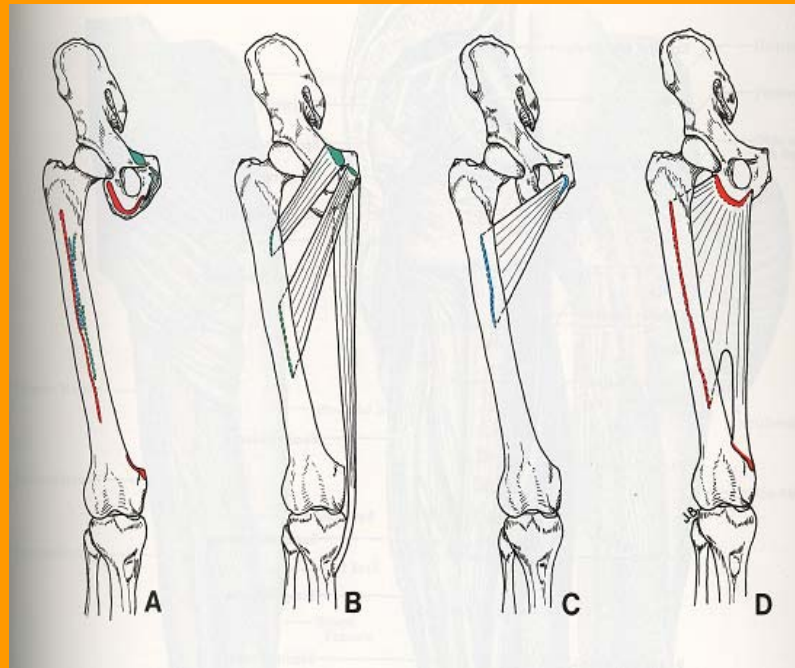


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Adductors

- Gracilis

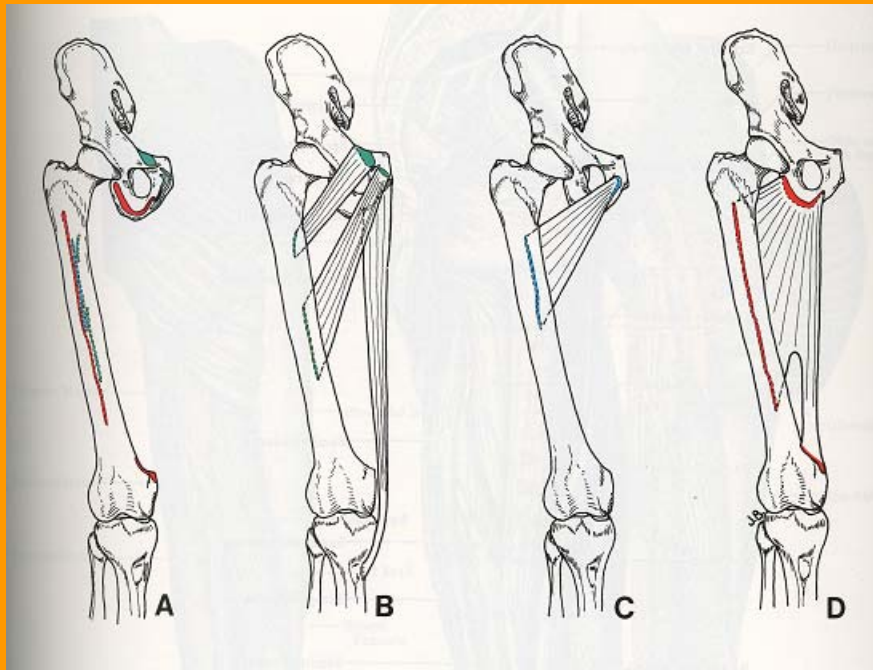
- Originates on the lower symphysis pubis and the pubic arch.
- Inserts on the medial tibia, below the condyle.
- Adduction of the hip, along with flexion and internal rotation.



Anderson, Grant's Atlas of Anatomy, Williams & Wilkins, 1983

Adductors

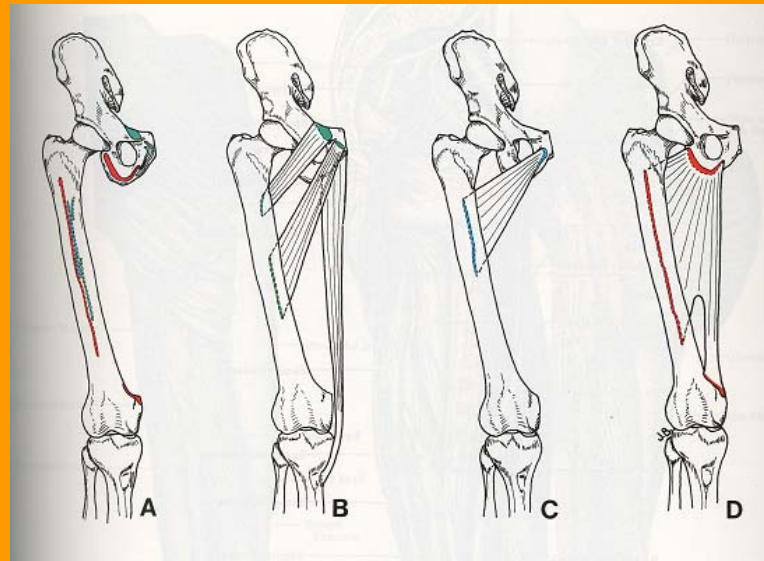
- Adductor Longus
 - Originates at the front of the pubis.
 - Inserts at the linea aspera in the middle 1/3 of the femur.
 - Adducts the hip, along with flexion and internal rotation.



Anderson, Grant's Atlas of Anatomy, Williams & Wilkins, 1983

Adductors

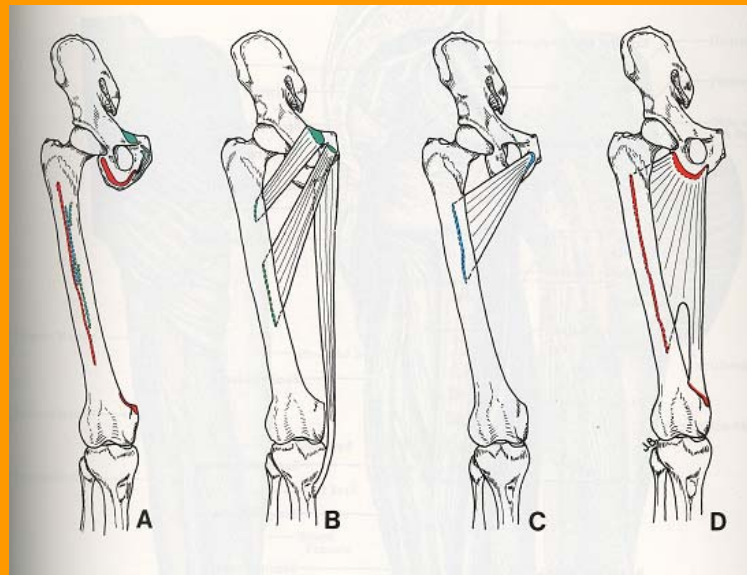
- Adductor Brevis
 - Originates on the inferior ramus of the pubis.
 - Inserts on the upper ½ of the linea aspera.
 - Adduction of the hip.



Anderson, Grant's Atlas of Anatomy, Williams & Wilkins, 1983

Adductors

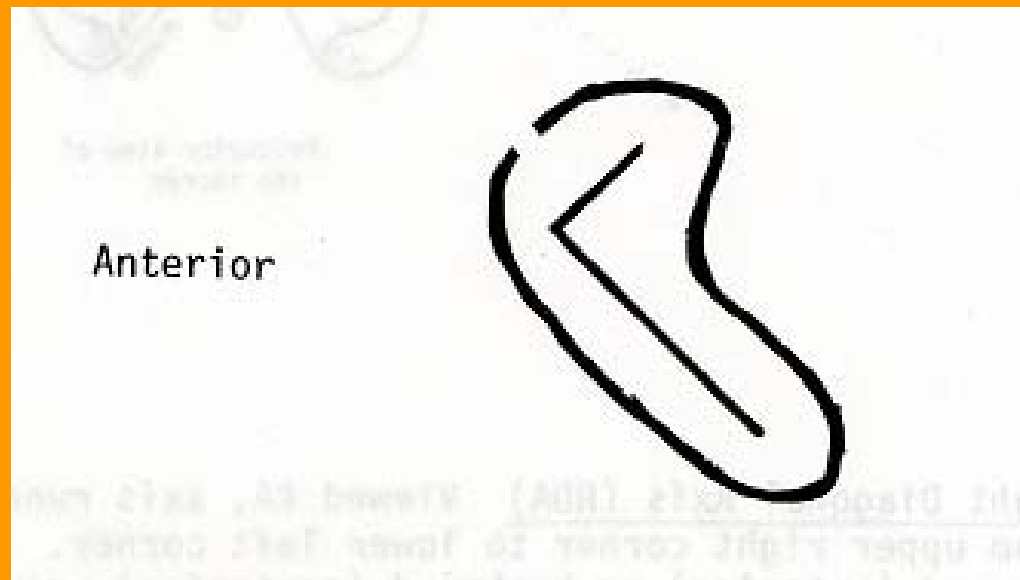
- Adductor Magnus
 - Originates on the front of the pubis, the ischium, and the ramus between the two.
 - Inserts on the entire length of the linea aspera and the adductor tubercle.
 - Adduction of the hip, along with internal rotation and flexion.



Anderson, Grant's Atlas of Anatomy, Williams & Wilkins, 1983

Sacroiliac Joint

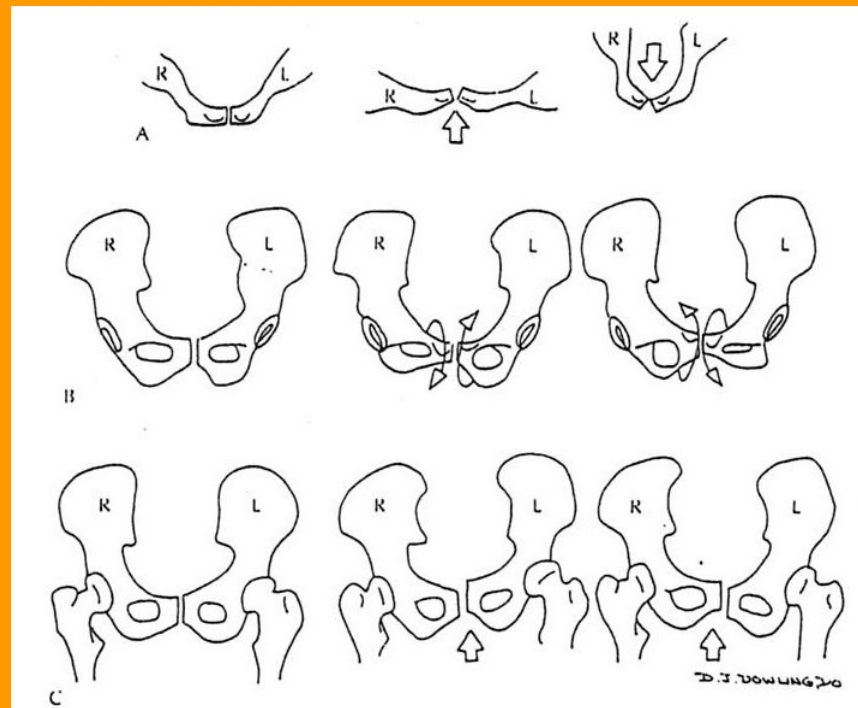
- Diarthrodial joint OR amphiarthrodial with diarthrodial characteristics.
- Auricular shaped, with the “long leg” meeting the “short leg” anteriorly.



Normal Mechanics vs. Pathomechanics

Normal Mechanics

- *Pubic Motions*
 - Caliper
 - Rotation
 - Superior/ Inferior Shear



Normal Mechanics

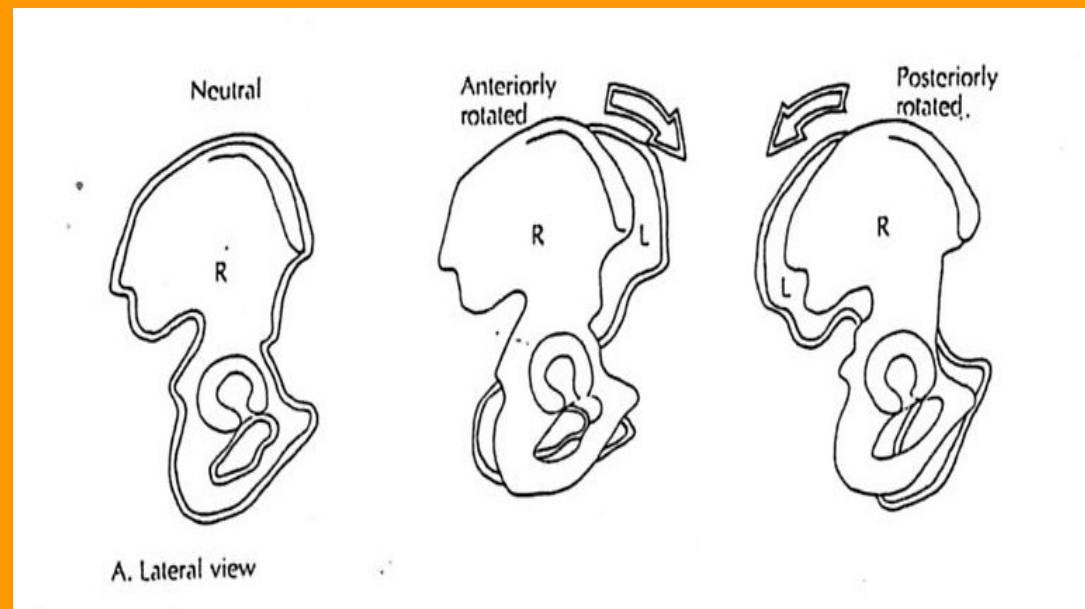
- *Iliosacral* = ilium moving on the sacrum with the sacrum being the fixed point.
- Three types of motion-
 - Caliper (flaring)
 - Anterior and Posterior Rotation
 - Superior and Inferior Shearing

Normal Mechanics

- Iliosacral
 - Caliper motion
 - The ilium moves posteriorly and laterally = *outflare*; **OR**,
 - The ilium moves anteriorly and medially = *inflare*.

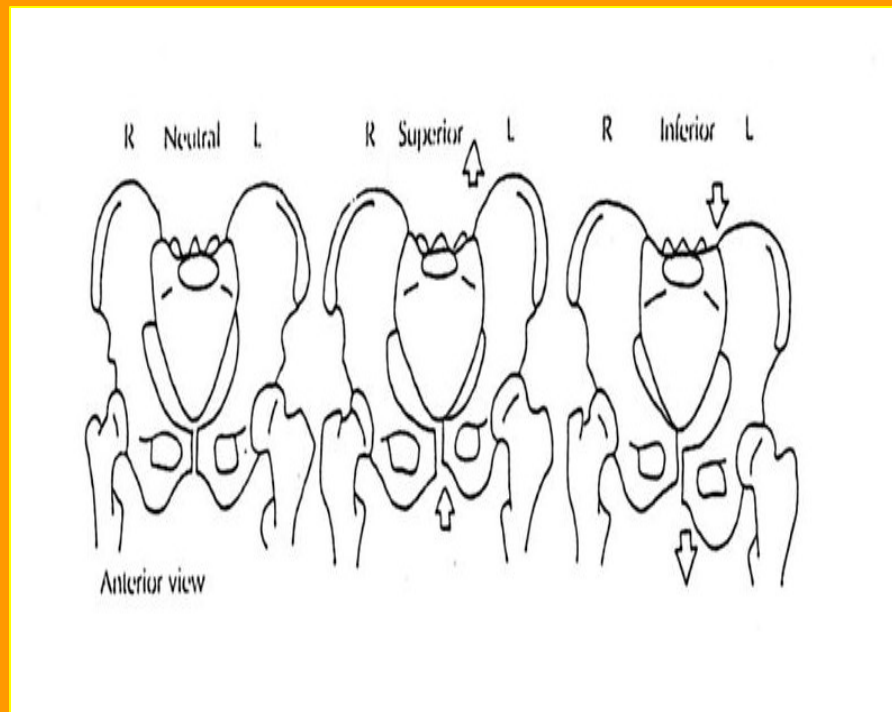
Normal Mechanics

- Iliosacral
 - Anterior Rotation, referred to as an *Anterior Innominate*; OR,
 - Posterior Rotation, referred to as a *Posterior Innominate*.



Normal Mechanics

- Iliosacral
 - Superior/ Inferior Shearing, referred to as an *Upslip* or a *Downslip*.



Normal Mechanics

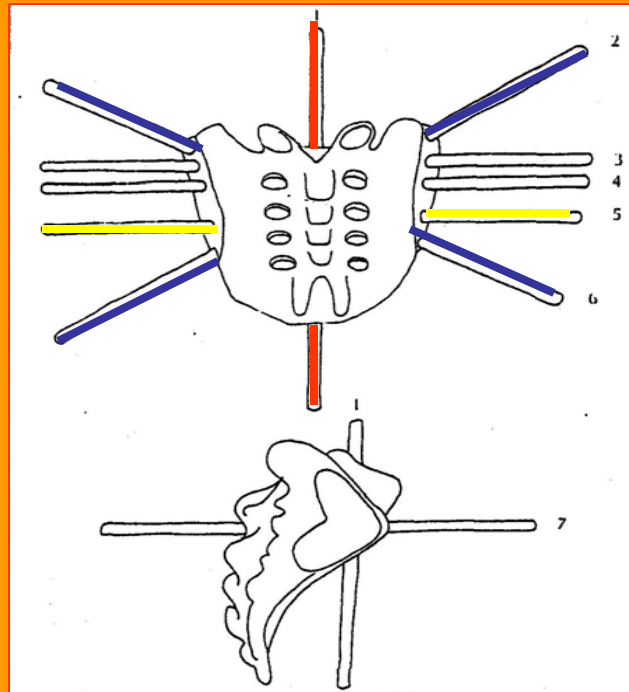
- *Sacroiliac* = sacrum moving on the ilium
 - The ilia are the fixed points.
 - Seated flexion and extension.

Normal Mechanics

- Sacroiliac
 - When the trunk extends, the sacrum flexes.
 - When the trunk flexes, the sacrum extends.
 - When the sacrum rotates, L₅ rotates in the opposite direction.

Normal Mechanics

- Sacroiliac
 - There are three major axes of motion:
 - **Horizontal** = sacral flexion and extension;
 - **Vertical** = sacral vertical shear; and
 - **Oblique** = sacral torsion



Pathomechanics

- Once we agree or understand that there is motion occurring at these joints, no matter how minimal, then we can agree or understand, that with pathology, these joints can become stuck, or *dysfunctional*.

Pathomechanics

- That being said, we can follow the McKenzie model of dysfunction.
- Pathology can occur when there is *abnormal stress on normal tissue* or when there is *normal stress on abnormal tissue*.

Pathomechanics

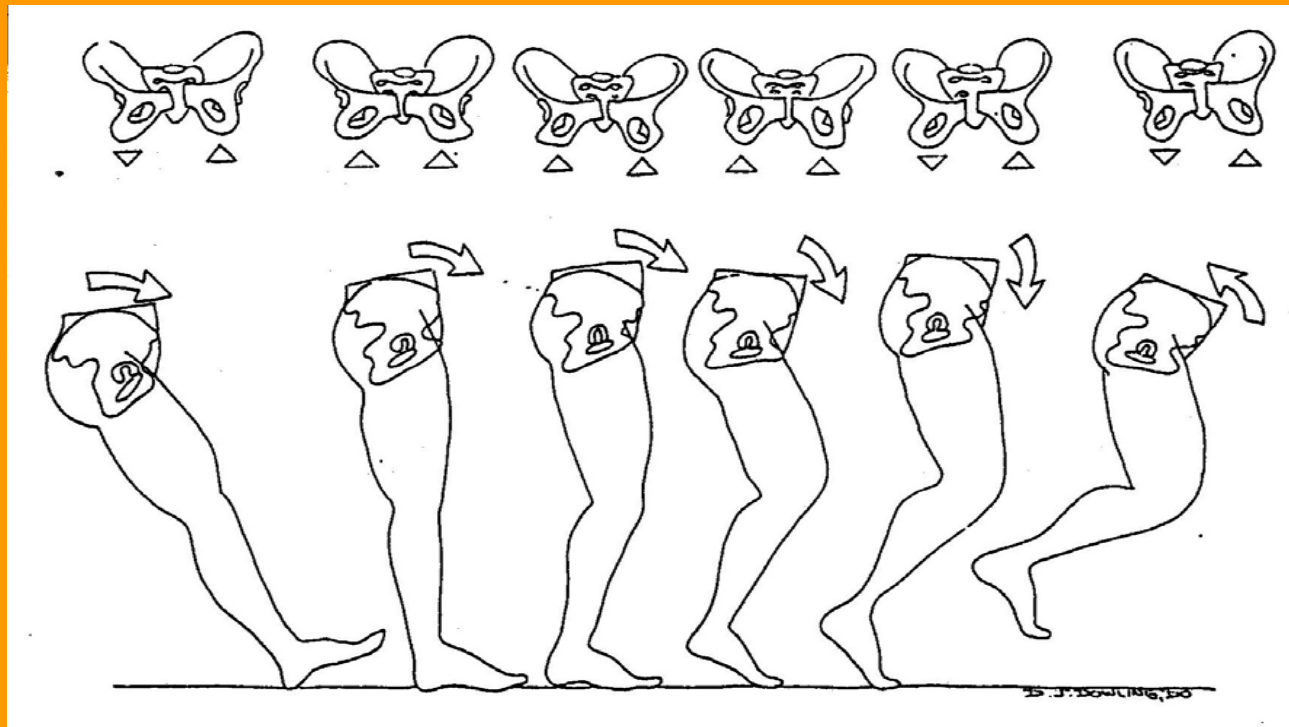
- *Abnormal stress on normal tissue*
essentially involves some type and level of trauma.

Pathomechanics

- *Normal stress on abnormal tissue*
essentially involves normal stresses on dysfunctional tissue.

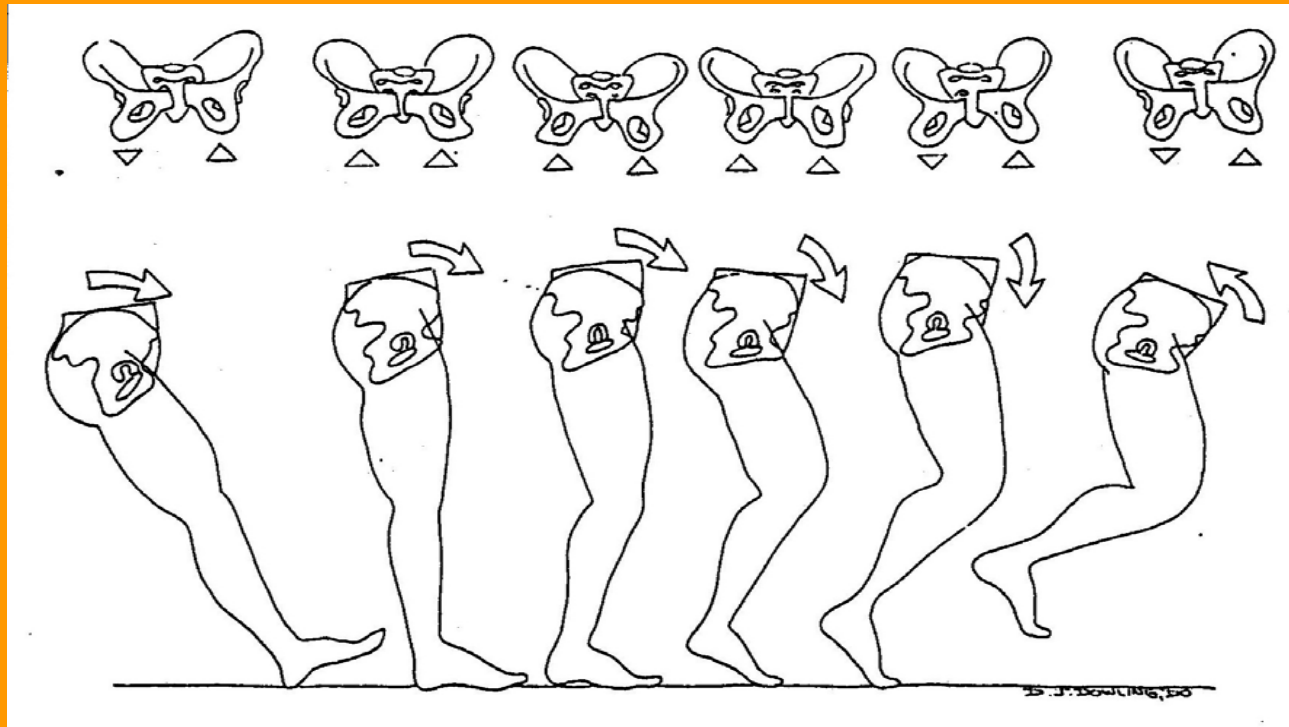
Biomechanics of Walking

- At heel strike, there is posterior ilial rotation and a forward sacral torsion on the weight bearing side.



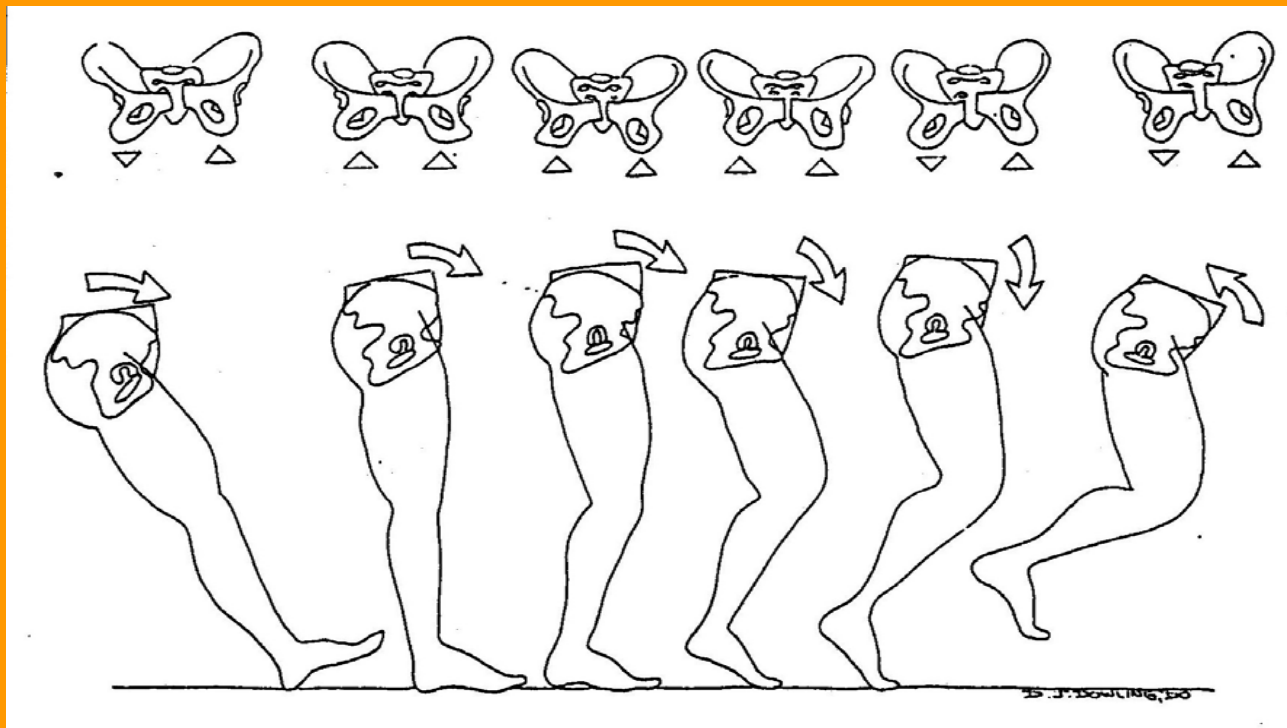
Biomechanics of Walking

- There is essentially no motion in the pelvis on the non- weight bearing side as the ilium remains anteriorly rotated.



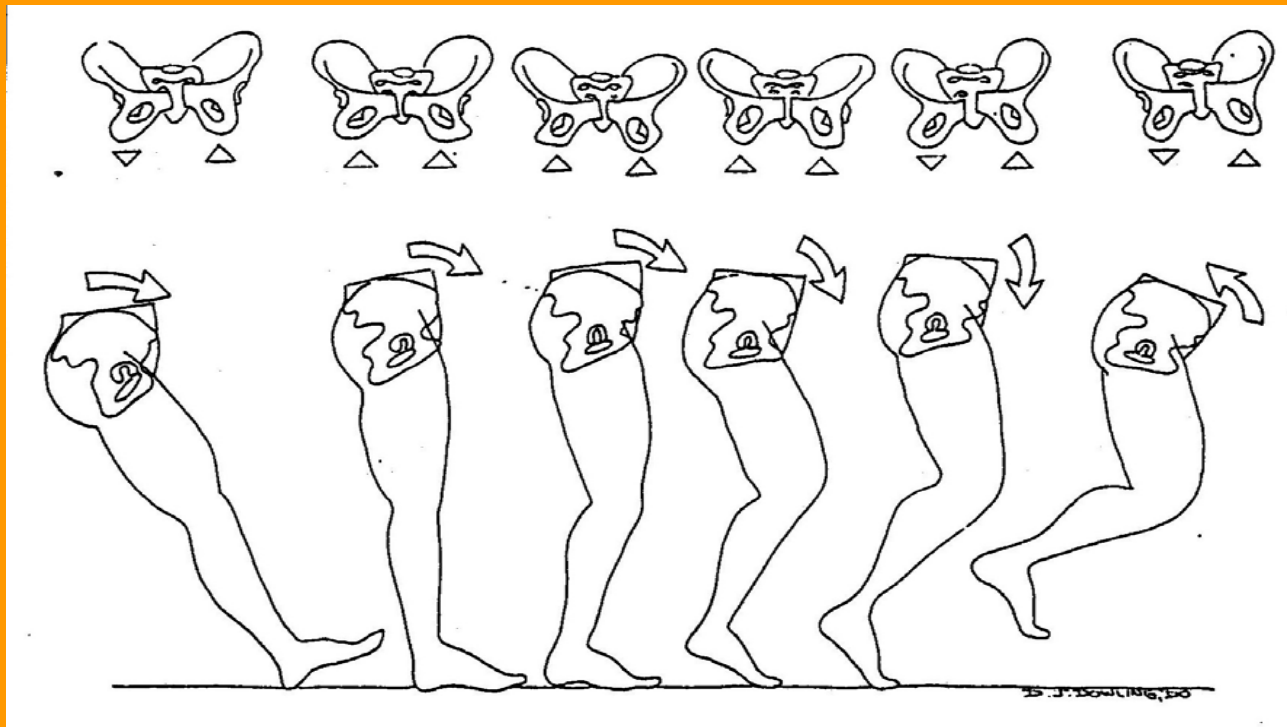
Biomechanics of Walking

- At the mid- point of the cycle, the ilium on the weight bearing side begins to move anteriorly, with the sacral torsion on that side at maximum.



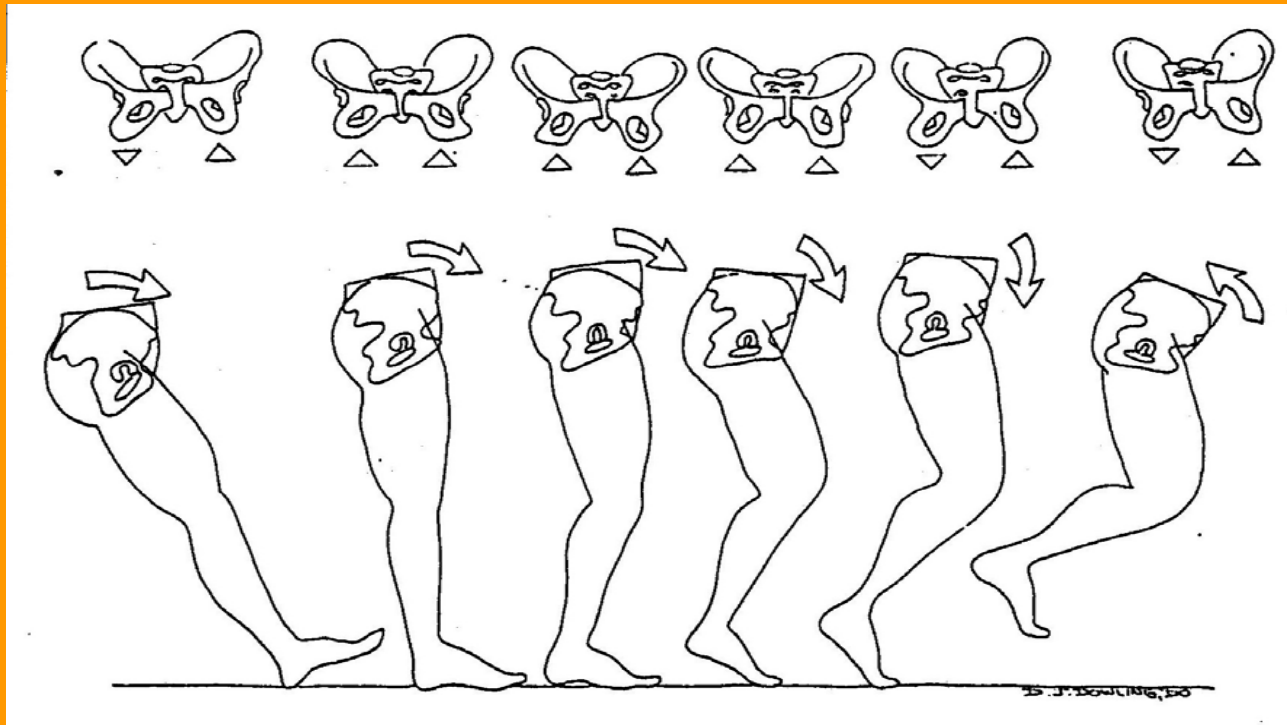
Biomechanics of Walking

- There has still not been any change on the non- weight bearing side.



Biomechanics of Walking

- As the opposite limb strikes the ground, the original weight bearing side changes from posterior to anterior ilial rotation and sacral torsion is eliminated.



Biomechanics of Walking

- The new weight bearing side now assumes the ilial and sacral changes previously mentioned.

